Which are the limits and how can we achieve nearly zero emission office buildings today?

Recent Evolution of the Key Drivers of Sustainable Buildings

An introduction to TOBEEM Project

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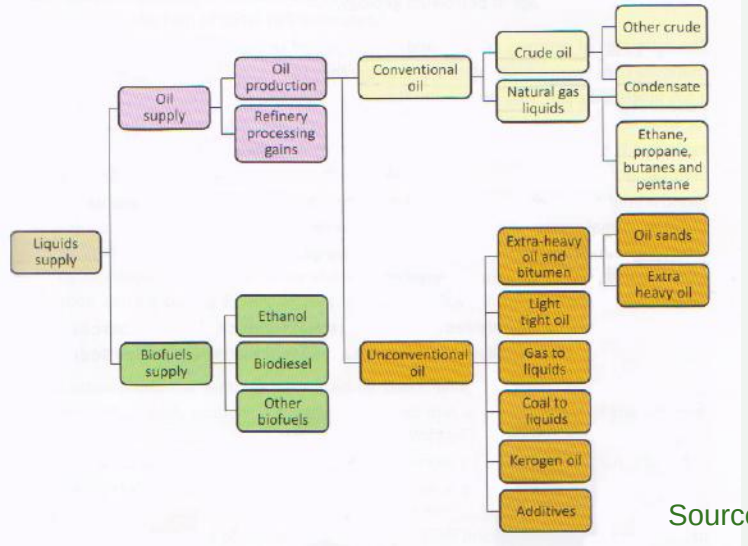
I – Recent evolution of the key drivers of sustainable buildings

1.- THE DIVORCE BETWEEN THE ENERGY AND THE CLIMATE CHANGE SPEECHES

-The amount of reserves of oil and gas has increased considerably in the last few years

A) Oil – Classification of Liquid Fuels

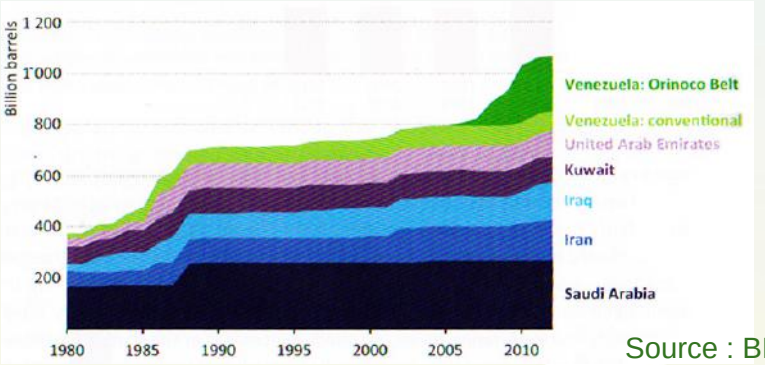


Source : WEO, 2013

CONVENTIONAL OIL
+
UNCONVENTIONAL OIL
+
BIOFUELS

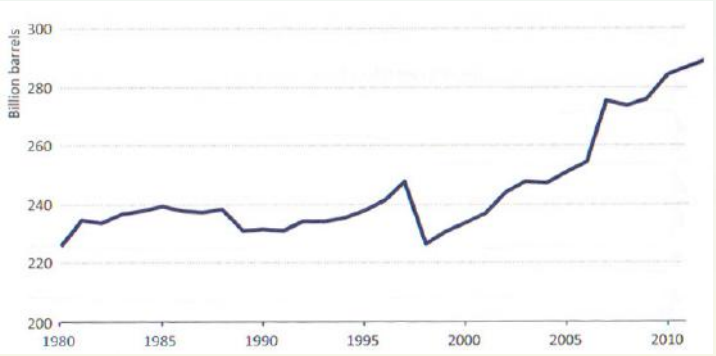
Evolution of Proven Reserves of Conventional Oil

For Selected OPEC Countries



Source : BP, 2013

For NON-OPEC Countries



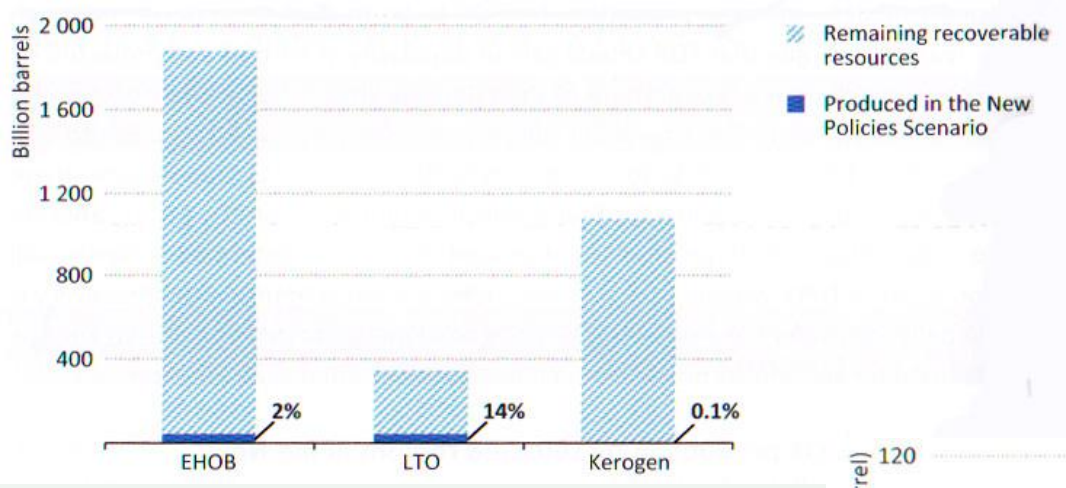
Source : BP, 2013

Proven reserves: 90% Probability of being produced (at current oil prices, with current technology and with final investment decision taken)

World total liquids supply 2014: 91Mb/d = 33 billion barrels/year

1.- THE DIVORCE BETWEEN THE ENERGY AND THE CLIMATE CHANGE SPEECHES (cont.)

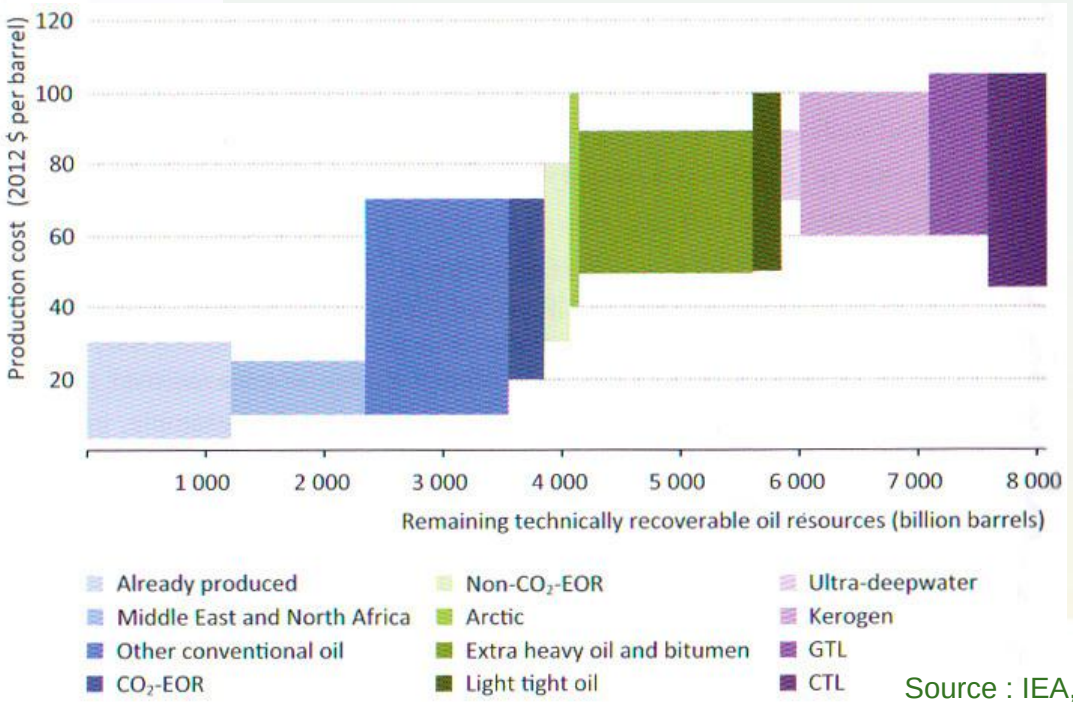
Cumulative Production 2013-2035 vs Remaining Recoverable Resources by Type of Unconventional Oil in New Policies Scenario



EHOB : Extra Heavy Oil and Bitumen
LTO : Light Tight Oil
KEROGEN: Solid Organic Matter Contained in Shales

Source : IEA, 2013

Supply Costs of Liquid Fuels by Source

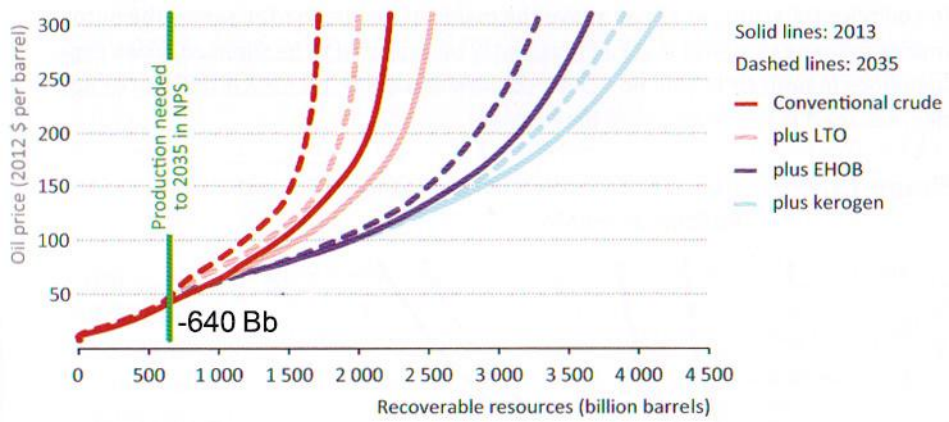


Source : IEA, 2013

1.- THE DIVORCE BETWEEN THE ENERGY AND THE CLIMATE CHANGE SPEECHES (cont.)

Supply Costs of Liquid Fuels (cont.)

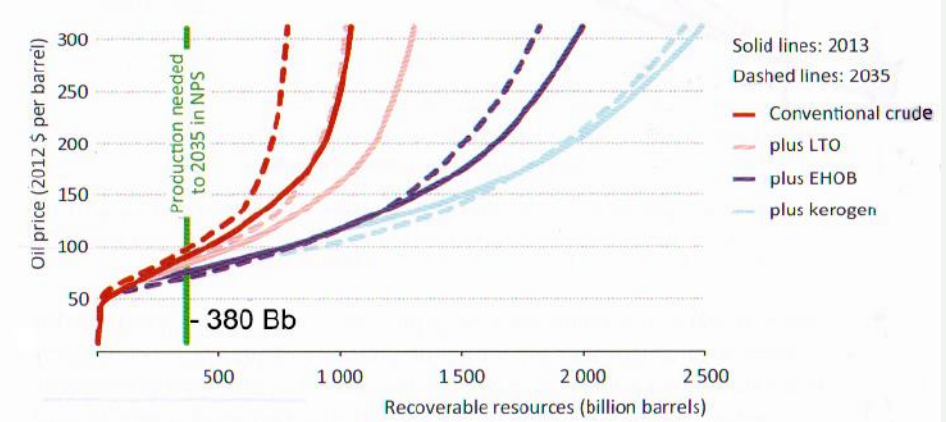
World Supply Cost Curves for 2013 and 2035 in New Possibilities Scenario



Source : IEA, 2013

→ **Costs: $50/barrel**

Non-OPEC Supply Cost Curves for 2013 and 2035 in New Policies Scenario



Source : IEA, 2013

→ **Costs: $80-90/barrel**

- **Remaining technically recoverable oil resources at a cost smaller than $105/b (2012): 6800 billion/barrel (Bb)**
- **World oil supply in new policies scenario**
  - **91 Mb/d in 2014 = 33 Bb/y**
  - **101 Mb/d in 2035 = 37 Bb/y → 180 years**

→ **HAS THE RISE OF UNCONVENTIONAL OIL RESOLVED THE DEBATE ABOUT PEAK OIL?**

1.- THE DIVORCE BETWEEN THE ENERGY AND THE CLIMATE CHANGE SPEECHES (cont.)

B) Natural Gas

-The unconventional resources of gas represent today 42% of total world gas resources

Remaining technical recoverable natural Gas Resources by Type an Region, 2012 (tcm)

	Conventional	Unconventional				Total
		Tight gas	Shale gas	Coalbed methane	Sub-total	
E. Europe/Eurasia	143	11	15	20	46	190
Middle East	124	9	4	-	13	137
Asia-Pacific	44	21	53	21	95	138
OECD Americas	46	11	48	7	66	112
Africa	52	10	39	0	49	101
Latin America	32	15	40	-	55	86
OECD Europe	26	4	13	2	19	46
World	468	81	212	50	343	810

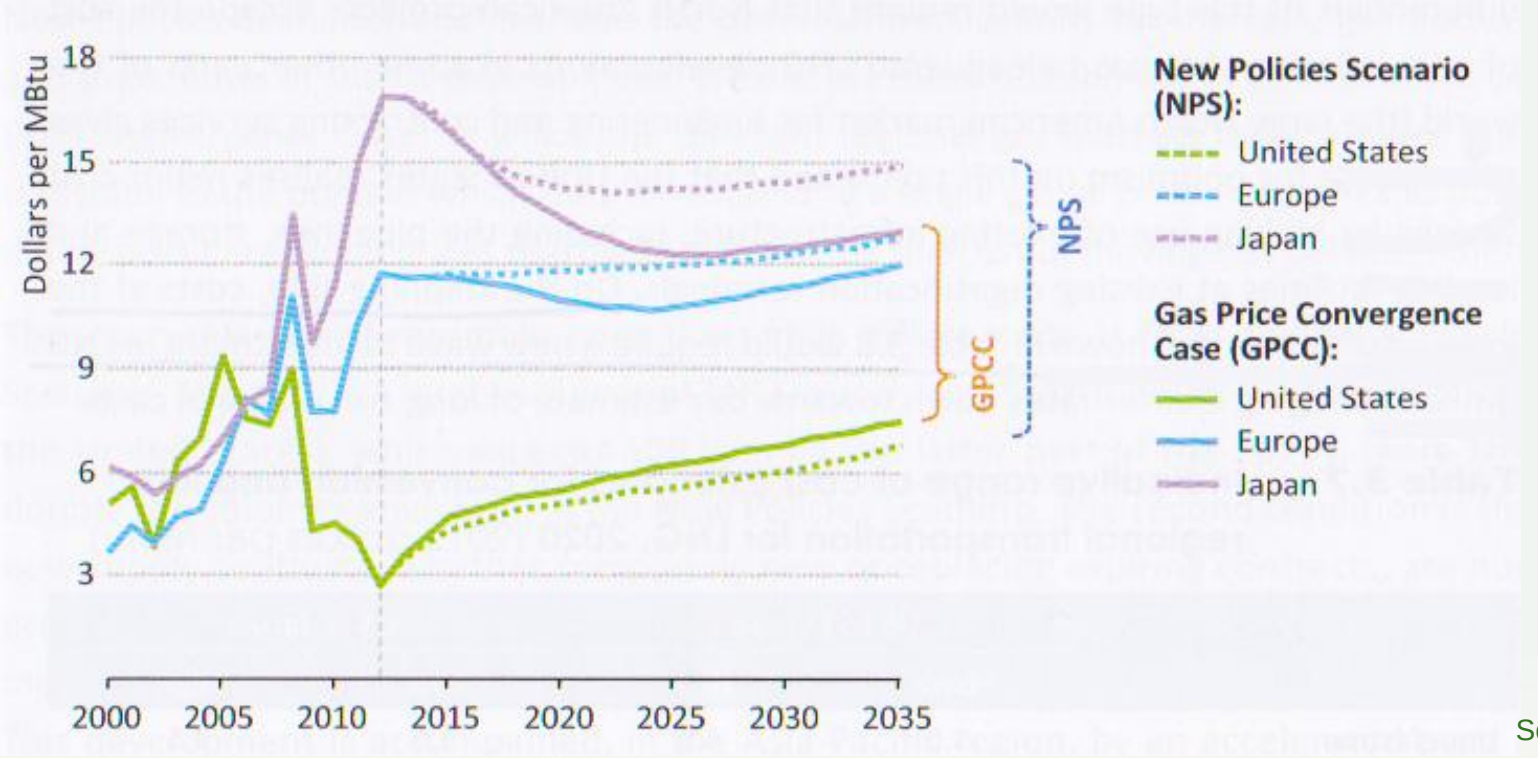
- Natural Gas Production in New Policies Scenario:
  - 2011: 3.4 tcm/y
  - 2035: 5.0 tcm/y ⟶ 162 years

Sources: BGR, 2012, USEIA, 2013 USGS, 2000, USGS, 2012a and 2012b, IFA, 2013

1.- THE DIVORCE BETWEEN THE ENERGY AND THE CLIMATE CHANGE SPEECHES (cont.)

B) Natural Gas (cont.)

- Great dispersion of prices by regions due to asymmetry in unconventional oil extraction



Source : IEA, 2013

- Consequences of the great increase in fossil fuel reserves in the last few years
  - Big geopolitical changes (i.e. USA may reach self-sufficiency in energy before 2035)
  - Dissociation of the energy and climate speeches

2.- THE CURRENT CLIMATE CHANGE SPEECH

- A World Climate Agreement would considerably increase the requirements for energy efficiency and GHG reduction for buildings
  - It would increase these requirements in the other sectors, energy supply, transport, industry and agriculture, forestry and others land uses
  - The EU has led the process but there is a big internal debate about the economic cost to be assumed
- The climate change debate is neither part of the political nor of the mediatic agenda
- The COP17 in Durban concluded with the commitment to reach a world climate agreement in 2015 (COP21 in Paris) legally binding from 2020 on for all countries, both advanced economies and developing countries
- Calendar of the most relevant events
  - September 2014: UN Head of States Summit on climate change → very disappointing results
  - December 2014: COP20 in Lima
  - December 2015: COP21 in Paris

→ A WORLD CLIMATE AGREMENT SEEMS VERY DISTANT AS OF NOW

- Main conclusion of the 5th assessment report published by the IPCC in 2013/2014
  - There is a probability bigger than 95% that more than 50% of global warming is of anthropogenic origin
  - Forecast for 2081/2100 relative to 1986/2005 (+0.61^{o}C relative to 1850 /1900)
    - △T: from +1.0^{o}C (RCP 2.6) to + 3.7^{o}C (RCP 8.5)
    - Sea level: from +40 cm (RCP 2.6) to +63cm (RCP 8.5)

2.- THE CURRENT CLIMATE CHANGE SPEECH (cont.)

- Reduction of GHG emissions relative to 2010 in order not to overtake the +2ºC goal (transitory temperature, not equilibrium temperature) relative to 1850/1900: -25% to -57% in 2050 and -73% to -114% in 2100
- Reduction of world consumption relative to base scenario (between +1.6% and +3% yearly) in 2100 relative to 2010 (equivalent to +300% to +900% in 2100 relative to 2010)

• Immediate action, global price for CO_2 and without technology limitation: -1.7% in 2030, -2.7% in 2050 and -4.7% in 2100

• Increase in cost due to delayed mitigation until 2030

▪ ≤ 55 $GtCO_2eq$ in 2030: +28% in 2030/2050 and +15% in 2050/2100

▪ > 55 $GtCO_2eq$ in 2030: +44% in 2030/2050 and +37% in 2050/2100 I

• Increase in cost due to limited availability of certain technologies

- ▪ Without carbon capture and storage: +39%
- ▪ Without nuclear energy: +13%
- ▪ Slow development of wind and solar technologies: +8%
- ▪ Slow development of bioenergy: +18

- Global temperature hiatus since 1998 until today, most probably due to

• 50% to internal climate variability

• 50% to the reduction of radiative forcing due to solar and volcanic activity (solar 11 year mínimum of 2008)

• Overestimation of temperature increase by climate models? We are near the lower limit of the forecasts

3.- EU ENERGY AND CLIMATE POLICY

- A) EU 2009 Green Package ⟶ Objectives for 2020
  - To reduce GHG emissions by 20% from 1990 levels
  - To cover the final energy demand with at least 20% of renewable energy (+ using renewable resources for al least 10% of transport fuel)
  - To enhance energy efficiency with respect to projected trends
- B) European Policy framework for climate and energy in the period 2020-2030 ⟶ Proposal of the Commission in January 2014 (not yet approved)
  - Reduction of GHG emissions by 40% from 1990 levels
  - A global share of at least 27% of renewable energy in the final energy demand, with no national limits

  ⟶ Not binding estimate: share of renewable energy in the production of electricity, from 21% today to 45% in 2030
- C) EU 2050 Energy Roadmap (December 2011) ⟶ 10 structural changes for the transformation of the energy system
  - The decarbonization of the economy is not only possible, it is less costly than current policies
  - More capital investment, lower costs of fuels
  - Electricity will almost double its share in the final energy demand, reaching 36 to 39% in 2050
  - Electricity price increase until 2030, and then decrease
  - Energy savings is a crucial issue
  - Large increase of the renewable energy sources: from 10% to 40% in final energy demand and will reach a share between 64% and 97% in electricity generation

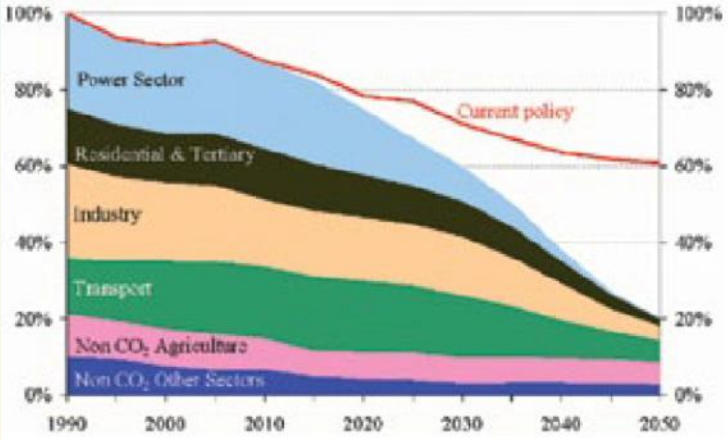
3.- EU ENERGY AND CLIMATE POLICY (cont.)

- C) <u>EU 2050 Energy Roadmap (December 2011) (cont.)</u>
  - Capture and Carbon Storage (CCS) is critical for the transformation of the system: 19% to 24% of electricity generation
  - Important contribution of nuclear energy
  - Interrelation between centralized and decentralized systems grows considerably
- D) <u>EU Roadmap for a Low-Carbon Economy in 2050 (March 2011)</u>
  - Objective: To contain global warming to under +2ºC relative to preindustrial global temperature

▪ World GHG emissions must be reduced by 50% in 2050 with respect to 2000

EU GHG emission abatement target for 2050 is 80 to 95% of the 1990 levels

80 % GHG EMISSIONS REDUCTION IN THE EU BY 2050



Source: European Commission

ABATEMENT BY SECTOR

Sector	GHG reduction compared to 1990		
	2005	2030	2050
Total	-7%	-40 a -44%	-79 a -82%
Electricity (CO_2)	-7%	-54 a -68%	-93 a -99%
Industry (CO_2)	-20%	-34 a -40%	-83 a -87%
Transport (incl. aviation, excl. maritime CO_2)	+30%	+20 a -9%	-54 a -67%
Residential and services (CO_2)	-12%	-37 a -53%	-88 a -91%
Agriculture (non-CO_2)	-20%	-36% a 37%	-42 a -49%
Other non-CO_2 emissions	-30%	-72 a 73%	-70 a -78%

Source: European Commission

3.- EU ENERGY AND CLIMATE POLICY (cont.)

- **E) <u>EU Energy Performance Building Directive (EPBD) 2010/31</u>**

• All new buildings from 2021 on must be NZEB (2019 for publicly owned buildings)

• Member States must include in their national buildings codes minimum energy efficiency requirements so that the new buildings are located in the regions of minimum global cost (Investment + Operations & Maintenance – Residual Value)

- **F) <u>EU Energy Efficiency Directive 2012/27</u>**

• The European Council of February 4th, 2011 admitted that the progress in energy efficiency was too slow in order to meet the 2020 objectives and additional measures were to be implemented

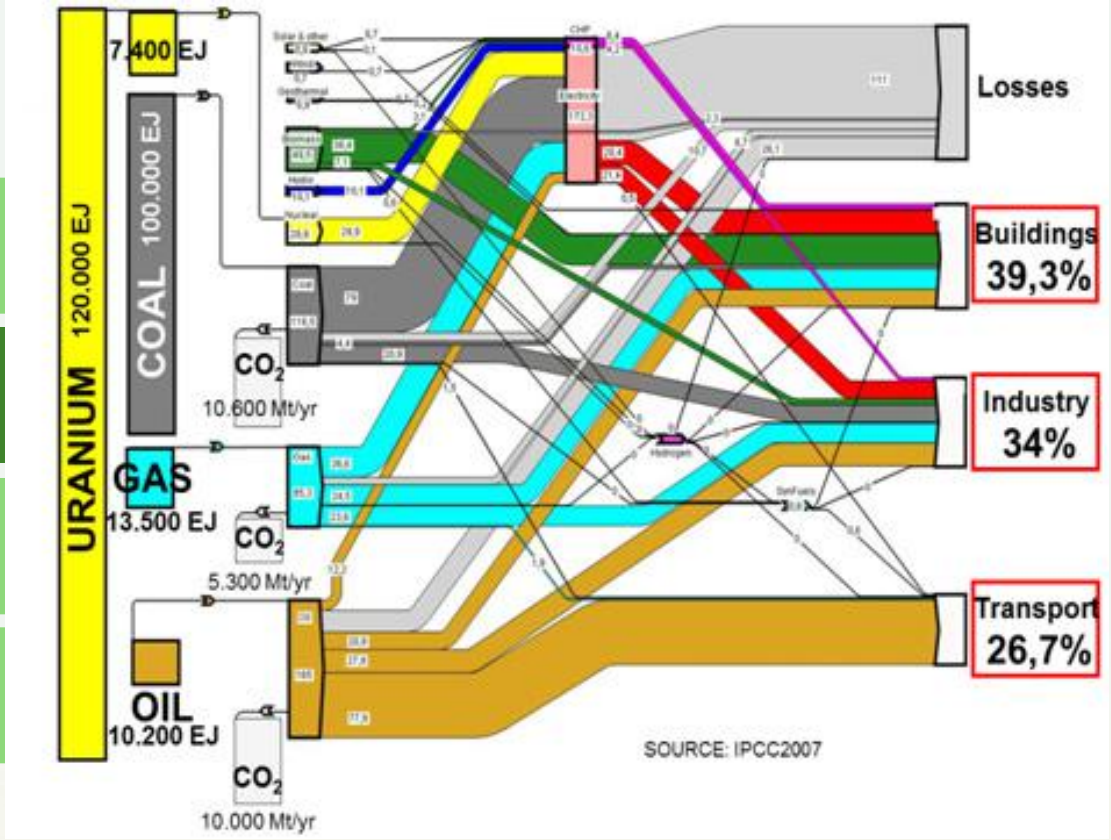
• Article 5: From 2014 on an annual 3% of all buildings owned and occupied by the Central Administration must be refurbished so that the energy requirements of EPBD 2010/31 are fulfilled

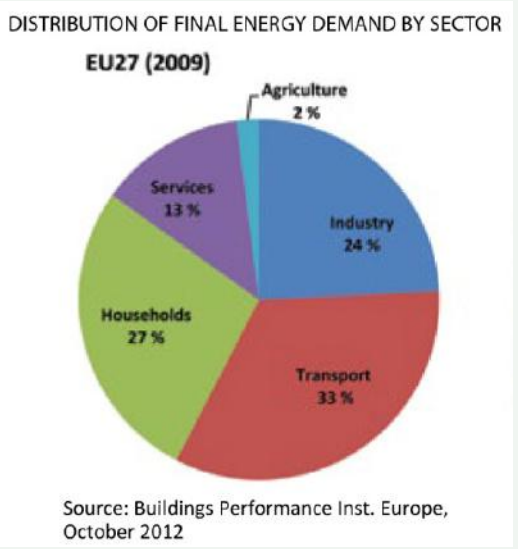
II – Introduction to TOBEEM Project

- **The Final Energy Demand and GHG Emissions of the Building Sector represent a big share of the total**

Worldwide Energy (in 2004, EI) from Primary to Final Energy

1 EJ (Exajoule) = 10^{18} Joules





BUILDING SECTOR

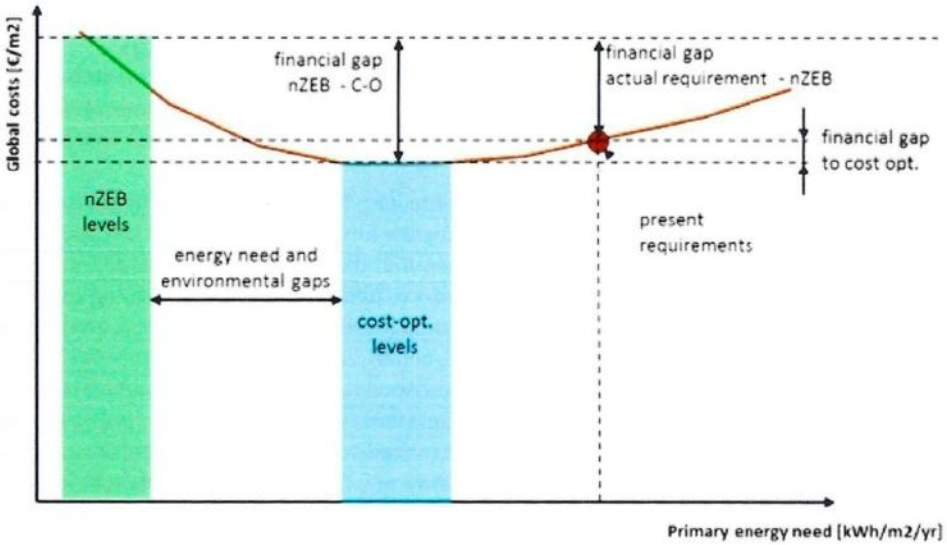
	FINAL ENERGY DEMAND (1)	GHG EMISSIONS (1)	SOURCE
EU 27 (2009)	40%	36%	BPIE, 2012
USA (2010)	39%	36%	USGBC, 2011

(1) The energy needed and GHG emissions in the process of fabrication of the building materials is not included

- **The energy intensity of some non-residential uses (office buildings, hospital, hotels) is much higher than for residential use**
  - **In Spain, energy intensity for office buildings is 7-8 times higher than for residential use**

- Goals of TOBEEM Project
  - To asses about the Reasonable Energy Efficiency Requirements for Office Buildings in the near future, considering:
    - Technologies and Architectural and Constructive Designs
    - Costs in the Life Cycle of the Building by using the Cost Optimal Methodology
    - Current building standards and its forecast evolution until 2020
  - To asses about the Parameters that allow the Optimization of Construction Costs vs. Operation of the Building and Comfort in Different Scenarios
  - To be useful as a Basis for future revisions of the Technical Requirements for Buildings for office use

- Global Cost in the Life Cycle of the Building
  - Global Cost in the Life Cycle of the Building = Investment + Operations & Maintenance (+ Price for CO_2 emissions) – Residual Value



$$C_g(\tau) = C_I + \sum_j \left[\sum_{i=1}^{\tau} \left(C_{a,i}(j) \times R_d(i) \right) - V_{f,\tau}(j) \right]$$

$C_g(\tau)$	Global costs referring to starting year τ_0
C_I	Initial investment costs
$C_{a,i}(j)$	Annual costs year i for energy-related component j (energy costs, operational costs, periodic or replacement costs, maintenance costs)
$R_d(i)$	Discount rate for year *I* (depending on interest rate)
$V_{f,\tau}(j)$	Final value of component *j* at the end of the calculation period (referred to the starting year $\tau 0$). Here also disposal cost (if applicable) can be taken into account.

Recent Evolution of the Key Drivers of Sustainable Buildings

Thank you for your attention

Luis Irastorza TECNOPEN